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(54) Title: INSULATION CONTAINING A MIXED LAYER OF TEXTILE FIBERS AND OF NATURAL FIBERS, AND PROCESS FOR PRODUCING THE SAME

(57) Abstract: An insulation product contains a mixed layer of textile fibers and of natural fibers. A process for manufacturing the insulation product includes passing fibrous bundles of textile fibers and of natural fibers together through an apparatus that divides the textile fibers into segments and that mixes the textile fiber segments with the natural fibers. The bundles of natural fibers can be in the form of specially manufactured mats and/or can be production scraps. The resulting mixture of fibers is formed into a non-woven bat, mat, blanket, or board. The process provides a mixed fibers product, with an improved combination of thermal and acoustic insulation and adequate strength, at a low production cost.

TITLE OF THE INVENTION

INSULATION CONTAINING A MIXED LAYER OF TEXTILE FIBERS AND OF NATURAL FIBERS, AND PROCESS FOR PRODUCING THE SAME

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION:

This invention relates to fiber insulation. More specifically, this invention relates to thermal and acoustic insulation containing a mixed layer of textile fibers and of natural fibers. This invention also relates to a process for manufacturing the mixed layer.

2. DESCRIPTION OF THE BACKGROUND

Glass and polymer fiber mats positioned in the gap between two surfaces can be used to reduce the passage of heat and noise between the surfaces.

Heat passes between surfaces by conduction, convection and radiation. Because glass and polymer fibers are relatively low thermal conductivity materials, thermal conduction along glass and polymer fibers is minimal. Because the fibers slow or stop the circulation of air, mats of the fibers reduce thermal convection. Because fiber mats shield surfaces from direct radiation emanating from other surfaces, the fiber mats reduce radiative heat transfer. By reducing the conduction, convection and radiation of heat between surfaces, fiber mats provide thermal insulation.

Sound passes between surfaces as wave-like pressure variations in air. Because fibers scatter sound waves and cause partial destructive interference of the waves, a fiber mat attenuates noise passing between surfaces and provides acoustic insulation.

Conventional fiber mats or webs used for thermal and acoustic insulation are generally made from extruded textile fibers or from extruded rotary or flame attenuated fibers. Textile fibers used in thermal and acoustic insulation are typically chopped into segments 2 to 15 cm long and have diameters of greater than 5 μm up to 16 μm. Rotary fibers and flame attenuated fibers are relatively short, with lengths on the order of 1 to 5 cm, and relatively fine, with diameters of 2 μm to 5 μm. Mats made from textile fibers tend to be stronger and less dusty than those made from rotary fibers or flame attenuated fibers, but are somewhat

inferior in insulating properties. Mats made from rotary or flame attenuated fibers tend to have better thermal and acoustic insulation properties than those made from textile fibers, but are inferior in strength.

Conventional fiber insulation tends to be expensive. Conventional fiber insulation also fails to provide a satisfactory combination of insulation and strength. Especially in ductliner applications, a need exists for new, low cost, fiber products with an improved combination of insulation, strength and handling characteristics. Processes to produce these products are also needed.

SUMMARY OF THE INVENTION

The present invention provides a fiber insulation product including a mixed layer of textile fibers and of natural fibers. The mixture of textile and of natural fibers in the mixed layer results in a low cost insulation product with superior thermal and acoustic insulation properties. The mixed layer can be formed by combining textile fibers and natural fibers, chopping the combined fibers together to mix and shorten the fibers, and then forming a mat from the mixed fibers.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiments of the invention will be described in detail, with reference to the following figures, wherein:

FIG. 1 shows a process for manufacturing an insulation product including a mixed layer of textile glass fibers and of rotary and/or flame attenuated glass fibers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The fiber insulation product of the present invention includes a mixed layer of textile fibers and of natural fibers.

The fibers in the mixed fiber layer can form a nonwoven porous structure. The nonwoven fibers can be in the form of a batt, mat, blanket or board. The textile fibers and natural fibers intermingle in the mixed layer. Preferably, the mixed layer is a uniform mixture of the textile fibers and of the natural fibers.

The textile fibers in the mixed layer can be organic or inorganic. Suitable organic textile fibers include cellulosic polymer fibers, such as rayon; and thermoplastic polymer fibers, such as polyester or nylon. Preferably, the textile fibers are inorganic. Inorganic fibers

include rock wool and glass wool. Preferably, the textile fibers are inorganic and comprise a glass. The glass can be, for example, an E-glass, a C-glass, or a high boron content C-glass.

Suitable natural fibers include animal fibers, such as wool, and vegetable fibers, such as cotton.

In embodiments, each of the textile fibers can be made of the same material and each of the natural fibers can be made of the same material. In other embodiments, different textile fibers can be made from different materials and different natural fibers can be made from different materials. Cost and insulation requirements will dictate the selection of the particular materials used in the textile and natural fibers. Preferably, the textile fibers are formed from starch coated or plastic coated E-glass. Preferably the natural fibers include cotton.

Textile fibers can be made in various ways known in the art. For example, textile fibers can be formed in continuous processes in which molten glass or polymer is extruded and drawn from apertures to lengths on the order of one mile. For use in insulation, the long textile fibers are divided into short segments by cutting techniques known in the art.

The textile fibers used in the insulation product of the present invention have diameters of from greater than 5 μm to about 16 μm. Preferably the textile fibers are divided into segments with lengths of about 2 cm to about 15 cm, more preferably from about 6 cm to about 14 cm.

Natural fibers can also be obtained in various ways known in the art. For example, natural fibers can be obtained by shearing fleece or hair from animals. Natural fibers can also be obtained by separating cellulose from plants using, e.g., processes used in papermaking.

Preferably, the natural fibers are cellulose fibers. Preferably, the cellulose fibers are obtained from recycled paper, such as recycled newsprint. Such recycled cellulose fibers can be purchased on the market and are frequently blown into walls and attics as insulation. These recycled cellulose fibers generally have lengths of from about 0.1 cm to about 0.5 cm and are in the form of small, thin pieces, or flacons. The flacons are irregularly shaped, and will generally fit through a diameter of 2 μm or less.

The mixed layer of textile fibers and of natural fibers according to the present invention can be manufactured in a variety of ways. For example, the mixed layer can be formed by dividing long textile fibers into textile fiber segments, mixing the textile fiber segments with natural fibers, and depositing the mixed fibers and fiber segments on a surface. The surface can be stationary or moving. Preferably, the surface is provided by a moving

conveyor or forming belt. The textile fibers can be divided in various ways known in the art, such as chopping textile fibers between two surfaces.

A particularly efficient means of forming the mixed layer involves passing pre-opened fiber nodules of textile fibers and a fibrous mat of natural fibers together through an apparatus configured to divide the fibers. The fibrous materials can each be either woven or non-woven, but are preferably non-woven. The fibrous mats of natural fibers can be specially manufactured and/or can include production scrap. In embodiments, only the textile fibers are divided in the fiber dividing apparatus. In other embodiments, both the textile fibers and the natural fibers are divided in the fiber dividing apparatus. An example of a fiber dividing apparatus is a tearing distribution system in which fibers are torn into fiber segments between interdigitated bars. Another example of such an apparatus is the combination of the above apparatus for natural fiber mat tearing and a cutting system in which textile fiber is cut by knives into fiber segments. Still another such apparatus is a sucking, negative pressure, or depression forming hood. Divided textile and natural fibers passing through the apparatus are deposited onto a surface to form a mixed layer of textile fiber segments and of natural fibers. Preferably, the surface is provided by a moving conveyor or forming belt. The mixed layer can be in the form of a fibrous batt, mat, blanket, or board.

A binder can be used to capture and hold the fibers in the mixed layer together. The binder can be organic or inorganic. The binder can be a thermosetting polymer, a thermoplastic polymer, or a combination of both thermoplastic and thermosetting-polymers. Preferably, the thermosetting polymer is a phenolic resin, such as a phenol-formaldehyde resin, which will cure or set upon heating. The thermoplastic polymer will soften or flow upon heating above a temperature such as the melting point of the polymer. The heated binder will join and bond the fibers. Upon cooling and hardening, the binder will hold the fibers together. When binder is used in the insulation product, the amount of binder can be from 1 to 30 wt%, preferably from 3 to 25 wt%, more preferably from 4 to 24 wt%. The binder can be added to and mixed with the fibers before or after the fibers are divided into small segments.

In embodiments, the thickness of the mixed layer of the insulation product of the present invention is preferably in a range from 10 to 150 mm, more preferably from 20 to 100 mm, most preferably from 25 to 52 mm. The percentage of textile fiber in the product can be in a range of 1 to 99%, preferably from 20% to 70% and more preferably from 25% to 50%. The higher the percentage of textile fiber, the stronger the product. However, higher

percentages of textile fiber lead to a reduction in acoustic and thermal insulation performance with high cost.

EXAMPLE

The following non-limiting example will further illustrate the invention.

FIG. 1 illustrates various embodiments of the invention. A bale of textile glass fibers is opened (not shown) and opened textile glass fibers 1 are deposited onto a conveyor (not shown). A loose fill of natural cellulose fibers 2 is combined with the opened textile glass fibers 1. A binder powder 3 is then added to the combined natural and textile fibers. The natural fibers 2, textile fibers 1 and binder powder 3 then enter a tearing apparatus 4 where the textile fibers are divided into small segments and mixed together with cellulose fibers to form a mixture of short fibers. The mixture of short fibers, along with the binder powder 3, form a uniform natural/textile fiber primary mat in which the textile fibers create a frame structure filled by natural fibers at the outlet of the negative pressure forming hood 5. When the primary mat passes through curing oven 6, the binder powder 3 flows to fix the fibers and form the finished insulation product 7.

Table 1 compares R-values (index of thermal insulation) and NRC-values (noise reduction coefficient) for a layer made of only textile fibers and a uniform layer of cellulose (25%) and textile (75%) fibers. The cellulose fibers are from recycled newsprint. The textile fibers are made from E-glass.

TABLE 1

Duct-liner Product: 1.5 pounds per cubic foot, 2.54 cm thick	R-value	NRC (Estimated)	Parting Strength (Estimated)
Layer of Textile Fibers only	3.6	0.60	5.0
Uniform layer of Cellulose (25%) and of Textile (75%) Fibers	3.8	0.60-0.65	4.0

Table 1 shows that a uniform layer of natural cellulose fibers and of textile fibers provides a higher R-value and a higher NRC value than a layer of only textile fibers, with slightly lower parting strength.

While the present invention has been described with respect to specific embodiments, it is not confined to the specific details set forth, but includes various changes and

modifications that may suggest themselves to those skilled in the art, all falling within the scope of the invention as defined by the following claims.

WHAT IS CLAIMED IS:

1. An insulation product comprising a mixed layer containing

first fibers each selected from the group consisting of animal fibers and plant fibers, and

second fiber segments each having a diameter of from greater than 5 μm to about 16 μm, wherein

the first fibers and the second fiber segments intermingle in the mixed layer.

2. The insulation product according to Claim 1, wherein the mixed layer is a uniform mixture of the first fibers and the second fiber segments.

3. The insulation product according to Claim 1, wherein the mixed layer further comprises a binder.

4. The insulation product according to Claim 3, wherein the binder comprises an organic polymer.

5. The insulation product according to Claim 1, wherein the plant fibers are from recycled paper.

6. The insulation product according to Claim 1, wherein the second fiber segments are each about 2 cm to about 15 cm long.

7. The insulation product according to Claim 1, wherein each of the second fiber segments comprises a glass.

8. The insulation product according to Claim 1, wherein each of the second fiber segments comprises a glass independently selected from the group consisting of an E-glass, a C-glass, and a boron doped C-glass.

9. The insulation product according to Claim 1, wherein each of the second fiber segments is an extruded fiber.

10. A process for forming an insulation product, the process comprising

passing a first fibrous material and a second fibrous material together through a fiber dividing apparatus to form a mixture of fibers, where the first fibrous material contains first fibers each selected from animal fibers and plant fibers and the second fibrous material contains second fibers each having a diameter of from greater than 5 μm to about 16 μm; and

forming the mixture of fibers into a non-woven batt, mat, blanket or board.

11. The process according to Claim 10, wherein the plant fibers are from recycled paper.

12. The process according to Claim 10, wherein

the fiber dividing apparatus divides the second fibers into second fiber segments each about 2 cm to about 15 cm long; and

the first fibers and the second fiber segments intermingle in the mixture of fibers.

13. The process according to Claim 12, wherein the mixture of fibers is a uniform mixture of the first fibers and the second fiber segments.

14. The process according to Claim 10, wherein each of the second fibers is an extruded fiber.

15. The process according to Claim 10, wherein the forming comprises

adding a binder to the mixture of fibers; and

heating the binder to bond the mixture of fibers.

16. The process according to Claim 15, wherein the heating is performed in an oven.

17. The process according to Claim 10, further comprising, before passing the first fibrous material and the second fibrous material together through the fiber dividing apparatus, adding a binder to the first fibrous material and the second fibrous material, wherein the forming comprises heating the binder to bond the mixture of fibers.

18. The process according to Claim 17, wherein the heating is performed in an oven.

19. The process according to Claim 10, wherein the passing comprises a step for dividing the second fibrous material into second fiber segments each about 2 cm to about 15 cm long.

20. The process according to Claim 10, wherein each of the second fibers comprises a glass.

21. The process according to Claim 10, wherein each of the second fibers comprises a glass independently selected from the group consisting of an E-glass, a C-glass, and a boron doped C-glass.

22. The process according to Claim 10, wherein the first fibrous material and the second fibrous material are both non-woven

23. The process according to Claim 10, wherein the fiber dividing apparatus comprises a negative pressure forming hood.

Textile glass fibers1

↓

Natural Cellulose fibers 2 ---------> ↓

↓

Binder powder 3 -----------> ↓

↓

Tearing apparatus 4

↓

Negative Pressure Forming Hood 5

↓

Curing Oven 6

↓

Finished Insulation Product 7

FIG. 1